IMPERIAL BUREAU
7 JAN 1928
MYCOLOGY

TECHNICAL BULLETIN
No. 10

August, 1927

UNITED STATES DEPARTMENT OF AGRICULTURE
WASHINGTON, D. C.

THE PRODUCTIVENESS OF CORN AS INFLUENCED BY THE MOSAIC DISEASE

By Hugo F. Stoneberg,

Assistant Agronomist, Office of Cereal Crops and Diseases, Bureau of Plant Industry[1]

Cooperative Investigations by the Office of Cereal Crops and Diseases, Bureau of Plant Industry, and the Louisiana Agricultural Experiment Station, Baton Rouge, La.

CONTENTS

	Page		Page
Introduction	1	Experiments at Baton Rouge—Continued	
Review of literature	2	Effect of the mosaic disease on the number of ears	9
Experiments at Baton Rouge in 1925 and 1926	2	Effect of the mosaic disease on the filling of the ears	11
Symptoms of the mosaic disease	3	Discussion	16
Spread of the mosaic disease	5	Summary	18
Effect of the mosaic disease on yields	5		
Effect of the mosaic disease on suckering	8		

INTRODUCTION

During the past few years the mosaic disease has been very prevalent on corn in the sugar belt of Louisiana, especially in fields adjacent to sugar cane.[2] Cornfields with 50 to 100 per cent of mosaic-diseased plants have not been uncommon in many localities. As the disease affects sugar cane, the principal crop of the region, planters as a rule have been very much interested in it. On account of the reports of severe losses, some of the planters believe that the mosaic disease is injuring the corn crop materially in Louisiana.

[1] The writer wishes to express his appreciation to C. W. Edgerton, botanist and plant pathologist of the Louisiana Agricultural Experiment Station, for his valuable suggestions during the progress of this study and for assistance in revising the manuscript.

[2] "Grass mosaic" has been observed on corn only in close proximity to infected sugar cane. It is not known to be transmitted through the seed of corn, and all new infections apparently must come from infected growing plants, the original source of which is sugar cane. The disease in corn is therefore a factor only on cane plantations or near-by fields. Corn is a favored food plant for *Aphis maidis*, the insect vector of mosaic, and herein lies the economic significance of mosaic in corn. The mosaic disease is readily transmitted back to cane by the insect when it abandons corn in search of fresh food plants. The destructiveness of mosaic in sugar cane has been well established, the present depression in the Louisiana cane industry being attributable in a large measure to mosaic. A few planters, recognizing the danger of corn acting as a mosaic reservoir, have taken the precaution of planting corn from one-half mile to 1 mile from cane fields, or have even considered eliminating it altogether. The range of injury due to mosaic in different varieties of sugar cane varies from little or none to practically complete destruction.—*E. W. Brandes, Senior Pathologist in Charge, Office of Sugar Plants, Bureau of Plant Industry, United States Department of Agriculture.*

51899—27——1

In order to obtain definite data on the effect of the mosaic disease on corn, experiments were started at Baton Rouge, La., in 1925 and continued in 1926. The results of these experiments are given in this bulletin.

REVIEW OF LITERATURE

The mosaic disease of corn has been recognized for a number of years. Kunkel [3] states that its presence and destructive nature in the Hawaiian Islands were recognized by Lyon as early as 1914. Weston,[4] in 1917, reporting what probably was the mosaic disease in the island of Guam, stated: "This trouble did not appear nearly so destructive or extensive as in Hawaii, but in one field at Umatac it was causing considerable loss."

Brandes [5] observed the mosaic disease affecting corn in Porto Rico in 1919 and stated [6] that the disease was seen in Louisiana in the summer of 1919 and in Georgia in 1920. He wrote: "No figures are available on the amount of loss sustained on account of injury to corn." Although Brandes believed that no great damage had as yet been done in this country, he said: "Where a large percentage of the plants are affected the loss due to decreased size of ears is appreciable." He added: "When infection takes place early in the growing season, partial or complete sterility of the ears results."

Brandes and Klaphaak [7] published data in 1923 on the effect of the mosaic disease on 17 different varieties of corn tested in southern Georgia. The average weight of ear from 10 healthy plants was larger than the average weight of ear from 10 mosaic-diseased plants in each of the 17 varieties, some of the differences being large. The 10-plant yield of the healthy plants also exceeded that of the diseased plants in 11 varieties, the yield of the diseased plants being in excess in the other 6 varieties. The average difference in yield per 10-plant comparison was 74 grams in favor of the healthy plants.

In 1921 Kunkel [3] stated: "9 varieties of sweet corn, 2 varieties of pop corn, and 14 varieties of field corn have been shown to be susceptible to the disease. Several varieties are somewhat resistant but no variety is known to be immune." He further stated that all mosaic-diseased corn plants are more or less dwarfed, with shortened internodes. From his report it would appear that the mosaic disease of corn is more serious in Hawaii than in the United States.

Later, in 1927, Kunkel [8] suggested that the mosaic disease prevalent in corn in Hawaii is distinct from that which occurs in corn in Louisiana and other Southern States.

EXPERIMENTS AT BATON ROUGE IN 1925 AND 1926

A plot 400 feet long and 132 wide was used for the experiments at Baton Rouge in 1925. This plot was located between plots of sugar cane in which 100 per cent of the plants were diseased. The

[3] KUNKEL, L. O. A POSSIBLE CAUSATIVE AGENT FOR THE MOSAIC DISEASE OF CORN. Bul. Hawaii. Sugar Planters' Assoc. Expt. Sta. Bot. Ser. 3: 44–58, illus. 1921.

[4] WESTON, W. H. REPORT ON THE PLANT DISEASE SITUATION IN GUAM. Guam Agr. Expt. Sta. Rpt. 1917: 45–62, illus. 1918.

[5] BRANDES, E. W. THE MOSAIC DISEASE OF SUGAR CANE AND OTHER GRASSES. U. S. Dept. Agr. Bul. 829, 26 p., illus. 1919.

[6] BRANDES, E. W. MOSAIC DISEASE OF CORN. Jour. Agr. Research 19: 517–521, illus. 1920.

[7] BRANDES, E. W., and KLAPHAAK, P. J. CULTIVATED AND WILD HOSTS OF SUGAR-CANE OR GRASS-MOSAIC. Jour. Agr. Research 24: 247–262, illus. 1923.

[8] KUNKEL, L. O. THE CORN MOSAIC OF HAWAII DISTINCT FROM SUGAR-CANE MOSAIC. (Abstract.) Phytopathology 17: 3. 1927.

plot was planted February 26 with Calhoun Red Cob corn, the variety most commonly grown in Louisiana. Germination and emergence were reasonably good, satisfactory stands were obtained, and early growth was normal.

Four plots on different parts of the experiment station farm were used in 1926. All of these were adjacent to plots of sugar cane infected with the mosaic disease. Plots 1 and 2 were planted with Calhoun Red Cob corn February 26 and 27, respectively. For some unknown reason the plants in plot 1 emerged more quickly and grew more rapidly than those in plot 2 during most of the season. Plot 3 was planted March 15 with Yellow Creole corn, a variety grown widely in the sugar-cane belt of Louisiana. In plot 4 were planted, for comparative purposes, 13 varieties of corn, White Calhoun being used as the check. Unfavorable conditions prevented the planting of plot 4 until May 11, after which the corn made unusually rapid growth owing to the warmer weather.

The varieties and sources of seed used in plot 4 were as follows:

C. I. (Cereal Investigations) No. 220 × C. I. No. 218 (a cross between selfed lines), Calhoun Red Cob, Yellow Creole, White Creole, and White Calhoun from the Louisiana Agricultural Experiment Station, Baton Rouge; Cocke Prolific and Mosby Prolific from the Mississippi Delta Station, Stoneville, Miss.; Delta Prolific and Cocke Prolific from the Stoneville Pedigreed Seed Co., Stoneville, Miss.; Hastings Prolific from W. H. Burns, Franklinton, La.; Adam's Paradise from J. J. O'Beirne, Lake End, La.; Imperial White from Bowie Lumber Co., Bowie, La.; and Whatley Prolific from Whatley Bros, Helena, Ga.

The procedure followed was practically identical in 1925 and 1926. One week after the first evidence of mosaic was noted, all plants showing symptoms of the mosaic disease were labeled with dated tags. At weekly intervals thereafter, until the plants were fully developed, all other plants showing symptoms were tagged. Further observations were made on the diseased plants until maturity.

When the corn had matured completely the ears were harvested. The ears from the plants which had shown symptoms of the disease for the first time during each of the different weeks were gathered separately. For each diseased plant an adjacent or near-by healthy plant was selected as a standard for comparison or check. In all of the experiments, except that involving the miscellaneous varieties in 1926, a group of 10 diseased and 10 near-by healthy plants was treated as a unit of comparison, the number of such groups constituting the number of replications. In the varietal plot in 1926, because of the small number of plants of each, the comparisons were based on the total numbers of mosaic-diseased and comparable healthy plants of the miscellaneous varieties.

SYMPTOMS OF THE MOSAIC DISEASE

The symptoms of the mosaic disease in corn during the early growing season are similar to those of the mosaic disease in sugar cane. The symptoms are most apparent in the young leaves. The mosaic mottling may appear as more or less irregular patches or stripes of light green surrounded by normal dark-green tissue, or the light green may predominate and entirely surround small islands of normal green tissue. In the plants grown for these experiments the sharply defined mosaic mottling gradually disappeared as the season advanced. In 1925, even with careful examination, the diseased

plants previously showing excellent visible symptoms could be identified only by the tag after June 26. The diseased plants seemed to grow as rapidly as the healthy ones in both seasons. No dwarfing or shortening of the internodes was observed, and there was no apparent difference in height at maturity.

TABLE 1.—*Numbers of healthy corn plants and numbers and percentages of mosaic-diseased corn plants at the end of successive weeks, beginning with the first visible evidence of the disease and ending with full plant development, at Baton Rouge, La., in 1925 and 1926*

Plot and variety	End of week in which plants first showed disease	Height of plant	Number of healthy plants at end of preceding week	Previously healthy plants developing symptoms during the week		Total diseased plants
		Feet		*Number*	*Per cent*	*Per cent*
1925 plot:						
Calhoun Red Cob	April 20	1 –2	4,205	324	7.7	7.7
	April 27	2 –4	3,881	655	16.9	23.3
	May 4	4 –5	3,226	541	16.8	36.1
	May 11	5 –6	2,685	408	15.2	45.9
	May 18	6 –7	2,277	175	7.7	50.0
1926, plot 1: Calhoun Red Cob	May 17	2.5–3.5	1,825	137	7.5	7.5
	May 24	3.5–4.5	1,688	91	5.4	12.5
	May 31	4.5–6.0	1,597	80	5.0	16.9
	June 7	5.5–8.0	1,517	62	4.1	20.3
1926, plot 2: Calhoun Red Cob	May 25	3.0–4.0	1,453	86	5.9	5.9
	June 1	4.0–6.0	1,367	53	3.9	9.6
	June 8	6.0–8.0	1,314	41	3.1	12.4
1926, plot 3: Yellow Creole	June 2	2.0–3.5	2,389	77	3.2	3.2
	June 9	3.5–5.0	2,312	43	1.9	5.0
	June 16	5.0–7.0	2,269	28	1.2	6.2
	June 23	7.0–9.0	2,241	14	.6	6.8
1926, plot 4: White Calhoun check	June 17		1,177	68	5.8	5.8
	June 24		1,109	154	13.9	18.9
	July 1		955	91	9.5	26.6
Varietal plot: C. I. 220 × C. I. 218	June 17		95	11	11.6	11.6
	June 24		84	17	20.2	29.5
	July 1		67	9	13.4	38.9
Cocke Prolific (from Mississippi Delta Station)	June 17		95	10	10.5	10.5
	June 24		85	19	22.4	30.5
	July 1		66	2	3.0	32.6
Mosby Prolific	June 17		103	8	7.8	7.8
	June 24		95	21	22.1	28.2
	July 1		74	7	9.5	35.0
Hastings Prolific	June 17		102	6	5.9	5.9
	June 24		96	13	13.5	18.6
	July 1		83	13	15.7	31.4
Calhoun Red Cob	June 17		93	6	6.5	6.5
	June 24		87	15	17.2	22.6
	July 1		72	7	9.7	30.1
Yellow Creole	June 17		91	8	8.8	8.8
	June 24		83	17	20.5	27.5
	July 1		66	10	15.2	38.5
White Creole	June 17		98	4	4.1	4.1
	June 24		94	10	10.6	14.3
	July 1		84	6	7.1	20.4
Adam's Paradise	June 17		98	10	10.2	10.2
	June 24		88	18	20.5	28.6
	July 1		70	7	10.0	35.7
Imperial White	June 17		96	3	3.1	3.1
	June 24		93	6	6.5	9.4
	July 1		87	3	3.4	12.5
Whatley Prolific	June 17		104	10	9.6	9.6
	June 24		94	11	11.7	20.2
	July 1		83	3	3.6	23.1
Delta Prolific	June 17		100	7	7.0	7.0
	June 24		93	11	11.8	18.0
	July 1		82	3	3.7	21.0
Cocke Prolific (from Stoneville Pedigreed Seed Co.)	June 17		102	8	7.8	7.8
	June 24		94	15	16.0	22.6
	July 1		79	2	2.5	24.5
Total of varieties	June 17		1,177	91	7.7	7.7
	June 24		1,086	173	15.9	22.4
	July 1		913	72	7.9	28.6

SPREAD OF THE MOSAIC DISEASE

The mosaic disease spread rapidly and at a comparatively uniform rate during the growing season in 1925. Data on the spread during each of the five weekly periods are given in Table 1. Of the total number of plants, 7.7 per cent showed symptoms during the first week, 16.9 per cent of the remaining healthy plants showed symptoms during the second week, 16.8 per cent during the third week, 15.2 per cent during the fourth week, and 7.7 per cent during the fifth week. By this time the plants were fully developed, and 50 per cent of all the plants in the plot had shown symptoms of the mosaic disease.

The mosaic disease spread less rapidly in 1926 than in 1925, but at a comparatively uniform rate except in the varietal plot, where its increase was most rapid during the second week. Data on the spread are also given in Table 1. In 1926, by the time the plants were fully developed, 20.3 per cent of the plants in plot 1 (Calhoun Red Cob) had shown symptoms of the disease, 12.4 per cent in plot 2 (Calhoun Red Cob), 6.8 per cent in plot 3 (Yellow Creole), and 26.6 per cent in plot 4 (White Calhoun). With the exception of Imperial White, in which only 12.5 per cent of the plants showed the disease, the percentage of infection in the varietal plot was comparatively uniform, ranging from 20.4 per cent for White Creole to 38.9 per cent for C. I. No. 220 × C. I. No. 218.

EFFECT OF THE MOSAIC DISEASE ON YIELDS

Data on the yields of mosaic-diseased and of healthy plants in 1925 are given in Table 2. As previously noted, the data on 10 diseased plants and 10 adjacent healthy plants constituted a single comparison. The numbers of such comparisons or replications on which the average yields for plants developing symptoms during the different weeks are based are given in column 3 of Table 2. The total actual yields of ear corn and the computed acre yield are shown in columns 4 to 7. The mean differences in yield, in pounds per 10-plant comparison and in bushels per acre, are given in columns 8 and 9. These differences are the means of the differences for the numbers of replications stated in column 3. This accounts for the slight discrepancies between the differences indicated by columns 4 and 5 or 6 and 7 and those shown in columns 8 and 9. The probable errors shown for the differences also were computed directly from successive differences, to avoid any effect of correlated variation.

Yields from the plants showing symptoms of the disease during the first week were slightly larger than those from the healthy plants, whereas the yields from the other groups of diseased plants were slightly smaller than those from the corresponding healthy plants. The differences in yield were small, however, ranging in 1925 from an increase of 1.7 bushels to a decrease of 2.8 bushels. They are less than three times their probable errors, except in one case, and consequently can not be considered very significant. Considering all of the comparisons, the acre yield of the diseased plants was 1.6 ± 0.45 bushels less than that of the healthy plants. This difference is 3.6 times its probable error, and the odds are large that it was not due to chance. It is reasonable to conclude, therefore, that the yield of the diseased plants was reduced slightly in these experiments.

TABLE 2.—*Yields of ear corn from mosaic-diseased and from healthy plants of corn at Baton Rouge, La., in 1925 and 1926*

[Values in columns 8 and 9, including the probable errors, were computed directly from the successive differences in the 10-plant comparisons]

Plot and variety	Date ending week in which plants first showed disease	Number of comparisons	Total actual yield (pounds)		Acre yield (bushels)		Difference in yield	
			Mosaic-diseased plants	Healthy plants	Mosaic-diseased plants	Healthy plants	Per 10-plant comparison (pounds)	Per acre (bushels)
1	2	3	4	5	6	7	8	9
1925 plot:								
Calhoun Red Cob	Apr. 20	25	208.7	200.1	40.4±1.0	38.7±1.1	+0.344±0.22	+1.7±1.1
	Apr. 27	49	406.3	434.5	40.1± .7	42.9± .7	−.575± .16	−2.8± .8
	May 4	45	373.7	391.3	40.2±1.0	42.1± .8	−.391± .15	−1.9± .7
	May 11	31	253.8	265.1	39.6± .7	41.4± .6	−.365± .15	−1.8± .7
	May 18	13	109.8	114.6	40.9±1.2	42.7±1.2	−.369± .30	−1.8±1.5
Total or average		163	1,352.3	1,405.6	40.1± .42	41.7± .41	−.327± .09	−1.6± .45
1926, plot 1:								
Calhoun Red Cob	May 17	8	61.8	62.8	37.4± .6	38.0± .8	−.125± .20	−.6±1.0
	May 24	6	45.6	54.1	36.8± .3	43.6±1.3	−1.417± .31	−6.9±1.5
	May 31	6	46.0	50.9	37.1± .5	41.1± .8	−.817± .25	−4.0±1.2
	June 7	5	38.8	44.1	37.6±1.4	42.7±1.0	−1.060± .35	−5.1±1.7
Total or average		25	192.2	211.9	37.2± .41	41.0± .50	−.788± .14	−3.8± .69
1926, plot 2:								
Calhoun Red Cob	May 25	5	37.4	39.7	36.2± .9	38.4± .8	−.460± .30	−2.2±1.5
	June 1	3	21.6	21.5	34.9±1.0	34.7± .9	+.033± .16	+.2± .8
	June 8	3	18.0	24.0	29.0±1.0	38.7±1.5	−2.000± .25	−9.7±1.2
Total or average		11	77.0	85.2	33.9± .57	37.5± .64	−.746± .14	−3.6± .69
1926, plot 4:								
White Calhoun	June 17	6	32.2	34.8	26.0±1.1	28.1±1.1	−.433± .40	−2.1±1.9
	June 24	14	77.1	80.9	26.7±1.0	28.0± .8	−.271± .21	−1.3±1.0
	July 1	7	41.3	42	28.6±1.1	29.2±1.5	−.129± .21	−.6±1.0
Total or average		27	150.6	157.9	27.0± .61	28.3± .68	−.270± .17	−1.3± .79
1926, varietal plot:								
C.I. 220×C.I. 218		29	12.9	14.5	21.5	24.2	−.552	−2.7
Cocke Prolific (from Mississippi Delta Station)		25	19.2	19.7	37.2	38.1	−.200	−.9
Mosby Prolific		34	29.3	25.1	41.7	35.7	+1.235	+6.0
Hastings Prolific		30	31.9	31.8	51.5	51.3	+.033	+.2
Calhoun Red Cob		22	16.2	13.8	35.6	30.4	+1.091	+5.2
Yellow Creole		30	24.3	23.9	39.2	38.6	+.133	+.6
White Creole		16	12.1	11.6	36.6	35.1	+.313	+1.5
Adam's Paradise		35	19.7	21.8	27.2	30.2	−.600	−3.0
Imperial White		10	6.0	8.8	29.0	42.6	−2.800	−13.6
Whatley Prolific		24	20.8	22.2	42.0	44.8	−.583	−2.8
Delta Prolific		20	15.0	15.3	36.3	37.0	−.150	−.7
Cocke Prolific (from Stoneville Pedigreed Seed Co.)		25	18.3	23.0	35.4	44.5	−1.880	−9.1
Total or average for all varieties		300	225.7	231.5	36.4	37.4	−.193	−1.00

The yields of the diseased and of the healthy plants in 1926 are also given in Table 2. Plot 3, planted with Yellow Creole corn, was harvested accidentally before records could be obtained. The differences in plots 1 and 2 and for White Calhoun in plot 4 are

clearly in favor of the healthy plants. Even the one difference in favor of the diseased plants (plants in plot 2 first showing symptoms of the disease during the week ending June 1) is less than its probable error. The average differences for Calhoun Red Cob corn in plots 1 and 2 are in good agreement, being 3.8 and 3.6 bushels per acre, with a probable error of ± 0.69 bushel in each case.

The yields from the White Calhoun plants in plot 4 exhibiting symptoms of the mosaic disease during each of the three weekly periods were less than those from the corresponding healthy plants. The differences in yield ranged from 0.6 bushel to 2.1 bushels. Each of these, as well as the average difference, 1.3 ± 0.79 bushels, is less than three times its probable error.

The yield data in 1926 for the varieties other than White Calhoun in plot 4 are given in the last section of Table 2. The limited numbers of plants made it possible to obtain only relatively few pairs of healthy and diseased plants of any one variety. All of the data for each variety accordingly were treated as a single test, as shown in Table 2. The differences in the acre yields from the healthy and mosaic-diseased plants ranged from 13.6 bushels in favor of the healthy plants of the Imperial White variety to 6 bushels in favor of the diseased plants of the Mosby Prolific variety. The 12 differences were divided almost equally as to direction, the healthy plants yielding more in 7 varieties, and the diseased plants yielding more in 5 varieties.

If it is assumed that the variation in the differences is evidence of differences in tolerance among the varieties, it necessarily would follow that the productiveness of about half of the varieties had been increased by the mosaic disease. It is highly probable, however, that the variation was almost entirely that to be expected with the small samples used. The data for the Calhoun Red Cob variety are particularly good evidence along this line. In plots 1 and 2 the acre yields from the mosaic-diseased plants of this variety were 3.8 ± 0.69 and 3.6 ± 0.69 bushels less than those from healthy plants. In the varietal plot, on the other hand, there was an indicated superiority for the diseased plants of 5.2 bushels.

Considering the data in Table 2 as representing a comparison between healthy and mosaic-diseased corn plants, without reference to variety, the acre yield of 300 diseased plants was 1 bushel less than that of 300 comparable healthy plants. This is in good agreement with the lower yield of 1.3 ± 0.79 bushels from the diseased plants of White Calhoun, the check variety in the same plot.

The data in Table 2 indicate that the mosaic disease probably was responsible for a decreased yield in both the Calhoun Red Cob and the White Calhoun varieties in 1926. The decreased acre yields were 3.8 and 3.6 bushels for Calhoun Red Cob and 1.3 bushels for the White Calhoun variety. Similarly, the average decrease in acre yield for the miscellaneous varieties in 1926 was 1 bushel. These results are in complete agreement as to direction both among themselves and with those obtained in 1925. The variation in the size of the differences may be considered as probably due to differences in the environment in the various experiments. Thus, by comparing the results obtained from Calhoun Red Cob in the two years, it would appear that the mosaic disease was responsible for a larger decrease in yield in 1926 than in 1925. Several conditions might have been responsible for such a difference, but no data are available

to indicate what they were. In any event, the largest decrease in acre yield was 3.8 bushels, or less than 10 per cent.

EFFECT OF THE MOSAIC DISEASE ON SUCKERING

Data on the effect of the mosaic disease on the production of tillers or suckers in 1925 are given in Table 3. The season of 1925 was very favorable for the production of suckers. Practically all of the corn in the sugar belt suckered very profusely. The diseased plants in the experimental plot showed a slightly greater tendency to sucker than the healthy plants. Considering the whole plot, the mosaic-diseased plants averaged 1.28 suckers per plant, whereas the healthy plants averaged 1.14 suckers per plant. The average difference per 10-plant comparison was 1.33 ± 0.19. As this difference is seven times its probable error, the odds are high that the difference was not due to chance. The disease appears to have increased the number of suckers by about 10 per cent.

Data on the effect of the mosaic disease on suckering in 1926 are given in Table 3. The season of 1926 was unfavorable for the production of suckers. The corn in the sugar belt produced very few suckers. Because of the small numbers of suckers produced, the numbers were not recorded for plot 4. In plots 1 and 2 there were 0.036 and 0.009 sucker per plant on the mosaic-diseased plants, whereas the healthy plants averaged 0.016 and 0 sucker per plant. These differences are too small to be considered of any importance. However, the tendency was the same as in 1925, the mosaic-diseased plants having slightly more suckers than the healthy plants in each case.

TABLE 3.—*Numbers and percentages of suckers on mosaic-diseased and on healthy plants of Calhoun Red Cob corn at Baton Rouge, La., in 1925 and 1926*

Values in the last column, including the probable errors, were computed directly from the differences in the 10-plant comparisons]

Plot	End of week in which plants first showed disease	Number of 10-plant comparisons	Total number of suckers on—		Average number of suckers per plant on—		Mean difference per 10-plant comparison
			Mosaic-diseased plants	Healthy plants	Mosaic-diseased plants	Healthy plants	
1925, plot	Apr. 20	25	304	293	1.22	1.17	0.44±0.05
	Apr. 27	49	661	571	1.35	1.17	1.78± .30
	May 4	45	546	491	1.21	1.09	1.22± .35
	May 11	31	403	355	1.30	1.15	1.55± .42
	May 18	13	165	150	1.27	1.15	1.15± .71
	Total or average	163	2,079	1,860	1.28	1.14	1.33± .19
1926, plot 1	May 17	8	2	1			
	May 24	6	4	1			
	May 31	6	2	0			
	June 7	5	1	2			
	Total or average	25	9	4	.036	.016	
1926, plot 2	May 26	5	1	0			
	June 1	3	0	0			
	June 8	3	0	0			
	Total or average	11	1	0	.009	0	

EFFECT OF THE MOSAIC DISEASE ON THE NUMBER OF EARS

Counts were made of the total, the marketable, and the unmarketable ears produced on mosaic-diseased and on healthy plants. Ears were considered unmarketable if they were less than 4 inches long,

FIG. 1.—Representative ears from 10 corn plants first showing symptoms of the mosaic disease during the first week of the experiments in 1925 (upper row) and from 10 comparable healthy plants (lower row)

if they were rotted, or if two-thirds of the ovules had failed to develop kernels. The data are given in Table 4.

In 1925 the mosaic-diseased plants produced 31 ears more than the healthy plants. On the other hand, 5.1 per cent more of the ears from healthy plants were in the marketable class. The small dif-

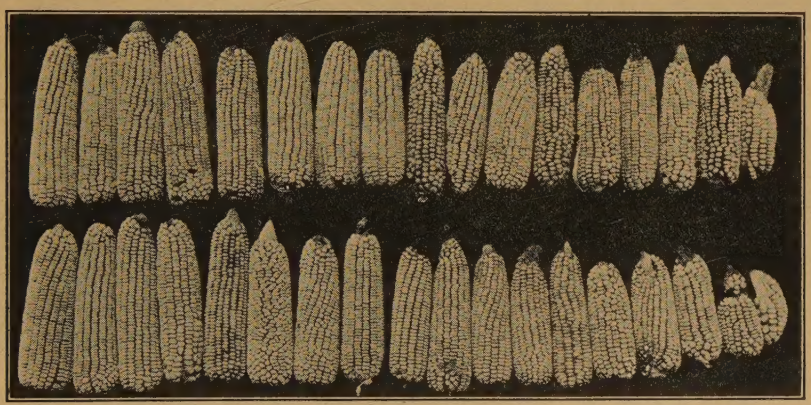

FIG. 2.—Representative ears from 10 corn plants first showing symptoms of the mosaic disease during the third week of the experiments in 1925 (upper row) and from 10 comparable healthy plants (lower row)

ference in the total number of ears probably may be accounted for by the fact that the mosaic-diseased plants produced a larger number of suckers, some of which probably produced nubbins. The difference in the percentage of marketable ears probably is due in part to

the same fact. The differences, however, are too small to be important. Representative ears from 10 plants which first showed symptoms of the mosaic disease during the first, third, and fifth weeks, respectively, together with ears from comparable healthy plants of Calhoun Red Cob corn in 1925, are shown in Figures 1, 2, and 3.

TABLE 4.—*Total numbers of ears and numbers and percentages of marketable ears from mosaic-diseased and from healthy corn plants at Baton Rouge, La., in 1925 and 1926*

Plot and variety	End of week in which plants first showed disease	Number of comparisons	Total number of ears		Number of marketable ears		Percentage of marketable ears	
			Mosaic-diseased plants	Healthy plants	Mosaic-diseased plants	Healthy plants	Mosaic-diseased plants	Healthy plants
1925 plot:								
Calhoun Red Cob	Apr. 20	25	382	357	280	283	73.3	79.3
	Apr. 27	49	759	747	546	602	71.9	80.6
	May 4	45	684	672	500	515	73.1	76.6
	May 11	31	451	476	324	343	71.8	72.1
	May 18	13	202	195	149	158	73.8	81.0
Total or average		163	2,478	2,447	1,799	1,901	72.6	77.7
1926, plot 1:								
Calhoun Red Cob	May 17	8	107	105	87	88	81.3	83.8
	May 26	6	80	86	61	71	76.3	82.6
	May 31	6	85	87	69	72	81.2	82.8
	June 7	5	67	61	58	56	86.6	91.8
Total or average		25	339	339	275	287	81.1	84.7
1926, plot 2:								
Calhoun Red Cob	May 26	5	65	70	58	65	89.2	92.9
	June 1	3	37	38	30	29	81.1	76.3
	June 8	3	38	39	30	37	79.0	94.9
Total or average		11	140	147	118	131	84.3	89.1
1926, plot 4:								
White Calhoun	June 17	6.7	77	81	63	69	81.8	85.2
	June 24	14.4	179	187	150	147	83.8	78.6
	July 1	7.5	101	97	82	79	81.2	81.5
Total or average		28.6	357	365	295	295	82.6	80.8
1926, varietal plot:								
C. I. No. 220×C. I. No. 218		29	30	29	26	28	86.7	96.5
Cocke Prolific (from Mississippi Delta Station)		25	59	53	40	47	67.8	88.7
Mosby Prolific		34	95	73	74	58	77.9	79.5
Hastings Prolific		30	108	119	91	96	84.3	80.7
Calhoun Red Cob		22	35	31	30	28	85.7	90.3
Yellow Creole		30	77	78	64	68	83.1	87.2
White Creole		16	32	32	26	29	81.3	90.6
Adam's Paradise		35	45	44	31	31	68.9	70.4
Imperial White		10	14	16	12	16	85.7	100
Whatley Prolific		24	75	71	54	56	72.0	78.9
Delta Prolific		20	45	39	31	33	68.9	84.6
Cocke Prolific (from Stoneville Pedigreed Seed Co.)		25	60	57	43	50	71.7	87.7
Total or average for all varieties		300	675	642	522	540	77.3	84.1

In 1926 the mosaic-diseased and the healthy plants in plot 1 produced the same number of ears, whereas in plot 2 the healthy plants produced a few more. The healthy plants produced 3.6 per cent more marketable ears in plot 1 and 4.8 per cent more in plot 2. Ears from 60 plants of Calhoun Red Cob corn in plot 1 first showing symp-

toms of the mosaic disease during the first week of the 1926 experiments and the ears from the 60 comparable healthy plants are shown in Figure 4. A similar comparison for 50 plants in the same plot first showing symptoms during the third week is shown in Figure 5.

The healthy plants of the White Calhoun variety produced a few more ears, but the mosaic-diseased plants had 1.8 per cent more ears in the marketable class. Ears from 40 plants of White Calhoun in plot 4 first showing symptoms of the mosaic disease during the first and third weeks, respectively, are shown in Figures 6 and 7, with ears from comparable healthy plants in each case.

In the 1926 varietal plot the mosaic-diseased plants produced more ears than the plants in 8 of the 12 varieties. Considering the total number of ears produced by all the varieties, the mosaic-diseased plants produced 33 more ears than the healthy plants. The healthy

FIG. 3.—Representative ears from 10 corn plants first showing symptoms of the mosaic disease during the fifth week of the experiments in 1925 (upper row) and from 10 comparable healthy plants (lower row)

plants produced a larger percentage of marketable ears in 11 of the 12 varieties. Considering the varietal plot as a whole, the healthy plants produced 6.8 per cent more marketable ears than the diseased plants. The differences are rather small. In nearly all of the varieties, however, the healthy plants produced a slightly larger percentage of ears in the marketable class. This, in connection with the average difference in favor of the healthy plants, makes it seem probable that the mosaic disease tended consistently but slightly to reduce the proportion of marketable ears.

EFFECT OF THE MOSAIC DISEASE ON THE FILLING OF THE EARS

As it had been stated that the mosaic disease tended to cause partial or complete sterility of the ears,[9] particular attention was given to this point.

Ears having more than half an inch of the apical end of the cob devoid of grain were classed as having barren tips. The numbers and percentages of ears with barren tips from healthy and diseased plants

[9] BRANDES, E. W. Op. cit. 1920.

FIG. 4.—Ears from 60 pairs of plants of Calhoun Red Cob corn in plot 1: A, From healthy plants; B, from plants first showing symptoms of the mosaic disease during the week ending May 17, 1926

FIG. 5.—Ears from 50 pairs of plants of Calhoun Red Cob corn in plot 1: A, From healthy plants; B, from plants first showing symptoms of the mosaic disease during the week ending May 31, 1926

are given in Table 5. The mosaic-diseased plants of Calhoun Red Cob produced 2.9 per cent fewer ears with barren tips in 1925, whereas in 1926 they produced 0.6 per cent and 1 per cent more ears with barren tips. Mosaic-diseased plants of the White Calhoun variety produced 1.9 per cent fewer ears with barren tips. In the other varieties, where only small numbers of ears of each variety were

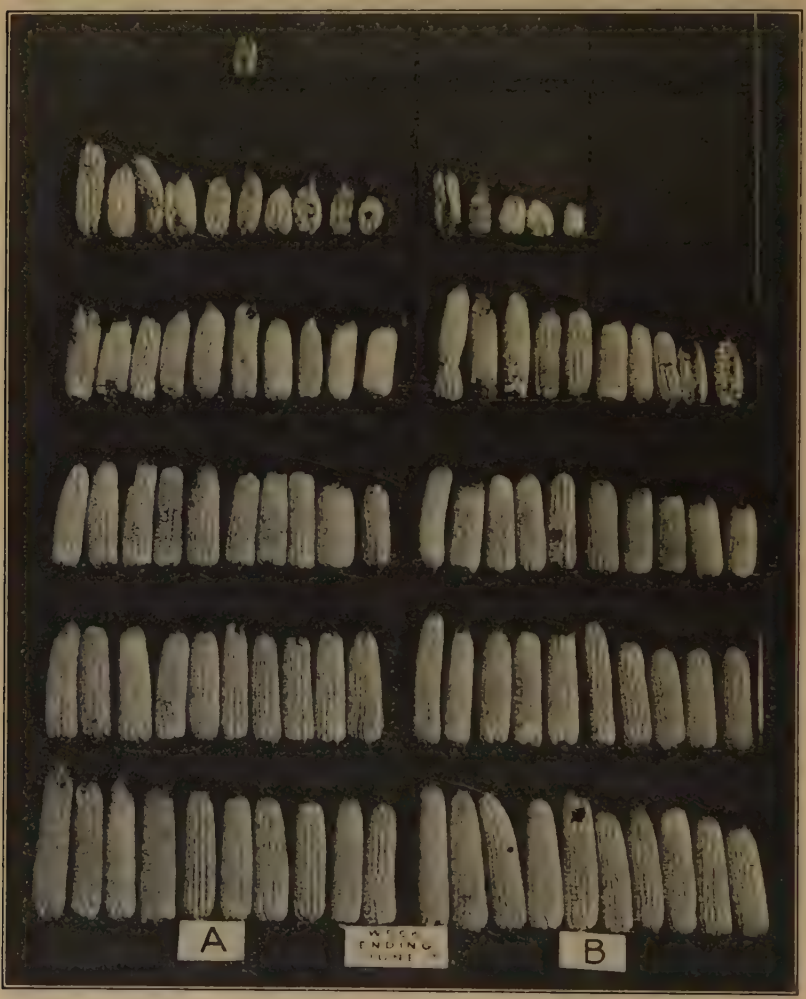

FIG. 6.—Ears from 40 pairs of plants of White Calhoun corn in plot 4: A, From healthy plants; B, from plants first showing symptoms of the mosaic disease during the week ending June 17, 1926

available, there was much fluctuation. Considering the total number of ears from all the varieties, the diseased plants produced 1.3 per cent more ears with barren tips.

In addition to determining the number of ears with barren tips, all of the ears harvested were classified on the basis of degree of filling, without reference to the portion of the ear where the deficiency of kernels occurred. The class values used were less than one-fourth

of kernel deficiency, one-fourth to one-half, one-half to three-fourths, and more than three-fourths of kernel deficiency. The distribution of the ears in these classes in 1925 is shown in Table 6. The healthy plants produced 2.2 per cent more of the ears having less than one-fourth of kernel deficiency than did the mosaic-diseased plants. It is evident both from the data and from the illustrations (figs. 1–7)

FIG. 7.—Ears from 40 pairs of plants of White Calhoun corn in plot 4: A, From healthy plants; B, from plants first showing symptoms of the mosaic disease during the week ending July 1, 1926

that the effect of the mosaic disease on the filling of the ears was not great.

The distribution of the ears in the various filling classes in 1926 is shown in Table 6. The mosaic-diseased plants produced somewhat smaller percentages of ears in the class having less than one-fourth of kernel deficiency and somewhat larger percentages of ears in the

classes with larger percentages of kernel deficiency. The differences, however, are small.

TABLE 5.—*Numbers and percentages of ears with barren tips produced by mosaic-diseased and healthy plants of corn at Baton Rouge, La., in 1925 and 1926*

Plot and variety	End of week in which plants first showed disease	Number of ears with barren tips		Percentage of ears with barren tips	
		Mosaic-diseased plants	Healthy plants	Mosaic-diseased plants	Healthy plants
1925 plot:					
Calhoun Red Cob	Apr. 20	207	200	54.2	56.0
	Apr. 27	400	431	52.7	57.7
	May 4	418	423	61.1	62.9
	May 11	276	301	61.2	63.2
	May 18	116	117	57.4	60.0
Total or average		1,417	1,472	57.2	60.1
1926, plot 1:					
Calhoun Red Cob	May 17	38	43	35.5	41.0
	May 26	32	36	40.0	41.9
	May 31	35	34	41.2	39.1
	June 7	29	19	43.3	31.1
Total or average		134	132	39.5	38.9
1926, plot 2:					
Calhoun Red Cob	May 26	31	33	47.7	47.1
	June 1	16	18	43.2	47.4
	June 8	21	19	55.3	48.7
Total or average		68	70	48.6	47.6
1926, plot 4:					
White Calhoun	June 17	42	48	54.6	59.3
	June 24	93	94	52.0	50.3
	July 1	49	53	48.5	54.6
Total or average		184	195	51.5	53.4
1926, varietal plot:					
C. I. No. 220×No. 218		22	25	73.3	86.2
Cocke Prolific (from Mississippi Delta Station).		25	24	42.4	45.3
Mosby Prolific		46	35	48.2	48.0
Hastings Prolific		61	72	56.5	60.5
Calhoun Red Cob		16	17	45.7	54.8
Yellow Creole		46	45	59.7	57.7
White Creole		17	17	53.1	53.1
Adam's Paradise		29	27	64.4	61.3
Imperial White		11	10	78.6	62.5
Whatley Prolific		49	35	65.3	49.3
Delta Prolific		35	28	77.8	71.8
Cocke Prolific (from Stoneville Pedigreed Seed Co.).		36	30	60.0	52.6
Total or average		393	365	58.2	56.9

Considering the data on barren tips and on degree of filling, together, it does not seem that the mosaic disease had any important effect upon fertilization or upon the subsequent development of the individual kernels as measured in these ways.

DISCUSSION

The data presented were obtained in two seasons, 1925 and 1926' the first having been very favorable for corn production and the second having been less favorable. All of the varieties used in the experiment are well adapted to southern conditions, and Calhoun Red Cob is grown extensively in the sugar belt of Louisiana. The abundant occurrence of the mosaic disease in the experimental plots

provided ample opportunity for study and for measuring accurately its effect on the development and yield of corn. Finally, although there was some variation in the results obtained, as a whole they were highly consistent. It is felt, therefore, that the results of these experiments are of value in showing the effects of the mosaic disease on corn under the conditions of the experiments which, in general, are not unlike those obtaining in the sugar belt of Louisiana.

TABLE 6.—*Percentage distribution of ears from mosaic-diseased and healthy corn plants into classes of stated degrees of kernel deficiency at Baton Rouge, La., in 1925 and 1926*

Plot and variety	End of week in which plants first showed disease	Degree of kernel deficiency							
		Less than one-fourth		One-fourth to one-half		One-half to three-fourths		More than three-fourths	
		Mosaic-diseased plants	Healthy plants	Mosaic-diseased plants	Healthy plants	Mosaic-diseased plants	Healthy plants	Mosaic-diseased plants	Healthy plants
1925 plot:									
Calhoun Red Cob	Apr. 20	83.8	85.4	7.3	6.2	3.7	1.7	5.2	6.7
	Apr. 27	83.3	87.2	6.5	6.2	4.2	2.4	6.1	4.3
	May 4	82.6	84.7	7.2	7.3	4.4	3.4	5.8	4.6
	May 11	83.6	82.1	7.1	8.8	3.5	3.4	5.8	5.7
	May 18	81.2	88.2	6.9	7.7	5.0	2.1	6.9	2.1
Average		83.1	85.3	6.9	7.1	4.1	2.8	5.9	4.8
1926, plot 1:									
Calhoun Red Cob	May 17	86.9	89.6	5.6	6.7	2.8	1.9	4.7	1.9
	May 26	80.0	88.4	13.8	5.8	2.5	2.3	3.8	3.5
	May 31	81.2	86.2	7.1	4.6	8.2	5.7	3.5	3.4
	June 7	83.6	98.3	7.5	0	6.0	0	3.0	1.6
Average		83.2	90.0	8.2	4.7	4.7	2.7	3.8	2.7
1926, plot 2:									
Calhoun Red Cob	May 26	92.3	88.5	3.1	10.0	3.1	0	1.5	1.4
	June 1	91.8	81.6	5.4	7.9	2.7	2.6	0	7.9
	June 8	68.4	97.4	15.8	2.6	7.9	0	7.9	0
Average		85.8	89.1	7.1	7.5	4.3	.7	2.9	2.7
1926, plot 4:									
White Calhoun	June 17	79.3	87.6	10.4	6.2	5.2	2.5	5.2	3.7
	June 24	80.4	83.4	8.9	7.5	6.2	5.9	4.5	3.2
	July 1	80.2	84.5	11.9	9.3	3.0	2.1	5.0	4.1
Average		80.1	84.7	10.1	7.7	5.0	4.1	4.8	3.6
1926, varietal plot:									
C. I. No. 220×C. I. No. 218		63.3	79.3	20.0	13.8	10.0	6.9	6.7	0
Cocke Prolific (from Mississippi Delta Station)		83.1	88.7	8.5	3.8	3.4	3.8	5.1	3.8
Mosby Prolific		77.9	83.5	4.2	8.2	8.4	4.1	9.5	4.1
Hastings Prolific		89.8	86.5	1.9	4.2	5.6	6.7	2.8	2.5
Calhoun Red Cob		97.2	83.8	0	9.7	2.9	6.5	0	0
Yellow Creole		84.5	85.9	7.8	9.0	5.2	3.9	2.6	1.3
White Creole		84.4	90.7	9.4	3.1	6.3	0	0	6.3
Adam's Paradise		73.4	77.2	8.9	11.4	8.9	4.5	8.9	6.8
Imperial White		78.6	87.5	7.1	12.5	7.1	0	7.1	0
Whatley Prolific		82.7	84.5	8.0	8.5	6.7	7.0	2.7	0
Delta Prolific		73.3	87.2	15.6	5.1	6.7	5.1	4.4	2.6
Cocke Prolific (from Stoneville Pedigreed Seed Co.)		71.6	91.3	16.7	1.8	6.7	7.0	5.0	0
Average		81.0	85.6	8.0	6.9	6.4	5.1	4.6	2.3

In these experiments the mosaic disease had no apparent effect upon the rate of growth or the total plant height. The mosaic-diseased plants did tend to sucker more and, possibly, to produce

more ears. These latter tendencies may be evidence of a tendency to proliferation which is a frequent concomitant of disturbance to normal development in corn. The data, however, are insufficient to more than suggest this.

The diseased plants produced lower yields of corn of slightly lower quality than did the healthy plants. In no case, however, were the differences large. Thus, the acre yields from the mosaic-diseased plants were less than those from the healthy plants by 1.6 ± 0.45, 3.8 ± 0.69, 3.6 ± 0.69, 1.3 ± 0.79, and 1 bushels in the different experiments. These differences indicate a slight loss due to the mosaic disease. At the same time there is nothing in the data to indicate that the mosaic disease is an important factor in materially reducing the yield of corn under conditions such as those described.

SUMMARY

The rate of development of the symptoms of the mosaic disease in experimental plantings of corn is noted. Data are reported on the relative yield, the numbers of suckers, and the numbers and quality of ears produced on mosaic-diseased and on comparable healthy plants.

The disease had no apparent effect on the rate of growth or the total height of the corn plants. The diseased plants tended to sucker slightly more and, possibly, to produce slightly more ears.

The yields from the diseased plants were lower in every extensive comparison, among which the largest difference in acre yield was 3.8 ± 0.69 bushels, or less than 10 per cent. The excess yield from diseased plants of some of the varieties in the varietal comparison probably were due to fluctuations resulting from the few plants of each variety available for comparison.

A larger proportion of the ears from the healthy plants were in the marketable class, and the ears tended to be slightly better filled. The differences were not important, however, in either case.

On the basis of the data it was concluded that, under the conditions described and as far as the experiments have gone, the mosaic disease was slightly deleterious to the yield and quality of corn, but could not be considered one of the important factors in reducing corn yields.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE,

August 16, 1927

Secretary of Agriculture	W. M. JARDINE.
Assistant Secretary	R. W. DUNLAP.
Director of Scientific Work	A. F. WOODS.
Director of Regulatory Work	WALTER G. CAMPBELL.
Director of Extension	C. W. WARBURTON.
Director of Personnel and Business Administration	W. W. STOCKBERGER.
Director of Information	NELSON ANTRIM CRAWFORD.
Solicitor	R. W. WILLIAMS.
Weather Bureau	CHARLES F. MARVIN, *Chief.*
Bureau of Animal Industry	JOHN R. MOHLER, *Chief.*
Bureau of Dairy Industry	C. W. LARSON, *Chief.*
Bureau of Plant Industry	WILLIAM A. TAYLOR, *Chief.*
Forest Service	W. B. GREELEY, *Chief.*
Bureau of Chemistry and Soils	C. A. BROWNE, *Acting Chief.*
Bureau of Entomology	L. O. HOWARD, *Chief.*
Bureau of Biological Survey	PAUL G. REDINGTON, *Chief.*
Bureau of Public Roads	THOMAS H. MACDONALD, *Chief.*
Bureau of Agricultural Economics	LLOYD S. TENNY, *Chief.*
Bureau of Home Economics	LOUISE STANLEY, *Chief.*
Federal Horticultural Board	C. L. MARLATT, *Chairman.*
Grain Futures Administration	J. W. T. DUVEL, *Chief.*
Food, Drug, and Insecticide Administration	WALTER G. CAMPBELL, *Director of Regulatory Work, in Charge.*
Office of Experiment Stations	E. W. ALLEN, *Chief.*
Office of Cooperative Extension Work	C. B. SMITH, *Chief.*
Library	CLARIBEL R. BARNETT, *Librarian.*

Bureau of Plant Industry	WILLIAM A. TAYLOR, *Chief.*
Office of Cereal Crops and Diseases	CARLETON R. BALL, *Senior Agronomist, in Charge.*

ADDITIONAL COPIES
OF THIS PUBLICATION MAY BE PROCURED FROM
THE SUPERINTENDENT OF DOCUMENTS
GOVERNMENT PRINTING OFFICE
WASHINGTON, D. C.
AT
5 CENTS PER COPY

▽